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INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Article 36 and Rule 70)

Applicant's or agent's file reference AA 1675 PCT	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/GB 03/04002	International filing date (day/month/year) 15.09.2003	Priority date (day/month/year) 13.09.2002
International Patent Classification (IPC) or both national classification and IPC F01N3/20		
Applicant JOHNSON MATTHEY PUBLIC LIMITED COMPANY		
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 5 sheets.</p>		
<p>3. This report contains indications relating to the following items:</p> <p>I <input checked="" type="checkbox"/> Basis of the opinion</p> <p>II <input type="checkbox"/> Priority</p> <p>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p>IV <input type="checkbox"/> Lack of unity of invention</p> <p>V <input checked="" type="checkbox"/> Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p>VI <input type="checkbox"/> Certain documents cited</p> <p>VII <input type="checkbox"/> Certain defects in the international application</p> <p>VIII <input type="checkbox"/> Certain observations on the international application</p>		
Date of submission of the demand 30.03.2004	Date of completion of this report 22.11.2004	
Address for mailing address of the international examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Sideris, M Telephone No. +31 70 340-3406 	

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/GB 03/04002**

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1-21

as originally filed

Claims, Numbers

1-37

filed with telefax on 21.10.2004

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

see separate sheet

6. Additional observations, if necessary:

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**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes: Claims	2,3,6-15,20-35
	No: Claims	1,4,5,16-19,36,37
Inventive step (IS)	Yes: Claims	
	No: Claims	1-37
Industrial applicability (IA)	Yes: Claims	1-37
	No: Claims	

2. Citations and explanations

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB 03/04002

Re Item I

Basis of the report

The amendments filed with the letter dated 21.10.2004 introduce subject-matter in claims 1 and 36 which extends beyond the content of the application as filed, contrary to Article 34(2)(b) PCT. The amendment concerned is the following:

"A combination of an oxidation catalyst, a catalysed soot filter, a NO_x-trap and a four way catalyst or a NO oxidation catalyst followed by a filter".

The combination of all the above components together is not implicitly or explicitly disclosed in a single embodiment of the application as filed.

The examination on novelty and inventive step will take place by omitting the above mentioned amendment.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:
D1: US 2002 0053202 A (Akama et al.)
D2: US 6 293 096 B (Khair et al.)
2. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 is not new in the sense of Article 33(2) PCT.

The document **D1** discloses:

A compression ignition (Diesel) engine operable in a first (lean), normal running mode and a second (rich) mode producing exhaust gas comprising an increased level of carbon monoxide (CO) relative to the first mode (see parag. [0044]) and means when in use to switch engine operation between the two modes (see parag. [0043]), which engine comprising an exhaust system comprising a supported palladium (Pd) catalyst associated with at least one base metal promoter (Cerium) (see parag. [0045]) and a supported platinum (Pt) catalyst downstream of the Pd catalyst (see parag. [0046]) wherein CO is oxidised by the supported Pd catalyst during second mode operation (see parag. [0045]).

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3. The same argumentation as in point 2 could be made *mutatis mutandis* with respect to the independent method claim 36 (Art. 33(2) PCT).
4. The subject-matter of claims 4, 5, 16-19, and 37 is not new in the sense of Article 33(2) PCT, because the technical features of these claims are disclosed in the description of document **D1** (see paragraphs [0040-0046]; figures).
5. The subject-matter of claims 2, 3, 6-15 and 20-35 does not involve an inventive step in the sense of Article 33(3) PCT.

The technical features of claims 2,3, 6-15 and 20-35 are merely some of several straightforward possibilities from which the skilled person would select, in accordance with circumstances, without the exercise of inventive skill, in order to solve the problems posed.

6. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1 and D2 is not mentioned in the description, nor are these documents identified therein.

CLAIMS:

1. A compression ignition engine operable in a first, normal running mode and a second mode producing exhaust gas comprising an increased level of carbon monoxide (CO) relative to the first mode and means when in use to switch engine operation between the two modes, which engine comprising an exhaust system comprising a supported palladium (Pd) catalyst associated with at least one base metal promoter and an optionally supported platinum (Pt) catalyst associated with and/or downstream of the Pd catalyst wherein CO is oxidised by the supported Pd catalyst during second mode operation.
2. An engine according to claim 1 configured to produce >2000ppm CO when running in the second mode.
3. An engine according to claim 1 or 2, comprising a catalytic converter comprising a first substrate, which first substrate comprising the supported Pd and the associated at least one base metal promoter.
4. An engine according to claim 3, wherein the catalytic converter comprises a second substrate downstream of the first substrate, which second substrate comprising the Pt catalyst.
5. An engine according to claim 3, wherein the first substrate comprises the supported Pd and the associated at least one base metal promoter on an upstream part of the substrate and the Pt catalyst on a downstream part thereof.
6. An engine according to claim 3, wherein the first substrate comprises a first layer comprising the Pt catalyst and a second layer overlying the first layer, which second layer comprising the supported Pd and the associated at least one base metal promoter.
7. An engine according to claim 3, wherein the first substrate is coated with a single washcoat layer, which layer comprising the supported Pd, the associated at least one base metal promoter and the Pt catalyst, wherein the Pd catalyst and the Pt catalyst are each supported on a separate and distinct particulate support material.

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8. An engine according to any of claims 3 to 7, wherein the first substrate, where present, the second substrate or the first and second substrates comprise a particulate filter.
- 5 9. An engine according to any preceding claim, wherein the exhaust system comprises a catalyst for catalysing the selective catalytic reduction (SCR) of NO_x with at least one NO_x -specific reactant disposed downstream of the supported Pd catalyst.
- 10 10. An engine according to claim 9, wherein the SCR catalyst comprises the Pt catalyst.
11. An engine according to claim 9 or 10, comprising means for introducing at least one NO_x -specific reactant into the exhaust system upstream of the SCR catalyst.
- 15 12. An engine according to any of claims 3 to 7, wherein the first substrate, where present, the second substrate or the first and second substrates comprise a NO_x absorber for absorbing NO_x in $\lambda > 1$ exhaust gas.
- 20 13. An engine according to claim 12, wherein the NO_x absorber comprises at least one alkali metal, at least one alkaline earth metal, at least one rare earth metal or any two or more thereof.
14. An engine according to claim 13, wherein the at least one alkali metal is potassium or caesium.
- 25 15. An engine according to claim 13, wherein the at least one alkaline earth metal is calcium, barium or strontium.
- 30 16. An engine according to 13, wherein the at least one rare earth metal is lanthanum or yttrium.
17. An engine according to any of claims 3 to 7, wherein the exhaust system comprises a catalyst for catalysing the reduction of NO_x with at least one non-selective reductant, such as H_2 or at least one HC reductant, which catalyst being disposed downstream of the supported Pd catalyst.

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18. An engine according to claim 17, wherein the NO_x reduction catalyst comprises the Pt catalyst.

19. An engine according to any of claims 3 to 7, wherein the exhaust system comprises a non-catalysed particulate filter disposed downstream of the supported Pd catalyst and associated at least one base metal promoter.

20. An engine according to any preceding claim, including an exhaust gas recirculation valve and a circuit to recirculate a selected portion of the exhaust gas to an engine air intake.

21. An engine according to claim 20, wherein the recirculated exhaust gas is cooled prior to mixing with the engine intake air.

22. An engine according to any preceding claim, wherein control of the first and second running conditions is effected, in use, by an engine control means.

23. An engine according to claim 22, wherein the engine control means comprises the engine control unit (ECU).

24. An engine according to any preceding claim, wherein the means for switching between the two modes switches between the first mode and the second mode when the Pt catalyst is <250°C.

25. An engine according to any preceding claim, wherein the Pd catalyst and the Pt catalyst are disposed on the same support.

26. An engine according to any preceding claim, wherein the at least one base metal promoter is a reducible oxide or a basic metal or a mixture of any two or more thereof.

27. An engine according to claim 26, wherein the at least one reducible oxide is an oxide of manganese, iron, copper, tin, cobalt or cerium.

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28. An engine according to claim 26 or 27, wherein the at least one reducible oxide is at least one of MnO_2 , Mn_2O_3 , Fe_2O_3 , SnO_2 , CuO , CoO and CeO_2 .
29. An engine according to claim 26, 27 or 28, wherein the reducible oxide is dispersed on the support.
30. An engine according to claim 26, 27 or 28, wherein the support *per se* comprises particulate bulk reducible oxide.
31. An engine according to claim 26, wherein the at least one basic metal is an alkali metal, an alkaline earth metal or a lanthanide metal or any mixture, compound oxide or mixed oxide of any two or more thereof.
32. An engine according to claim 31, wherein the at least one alkaline earth metal is barium, magnesium, calcium, strontium.
33. An engine according to claim 31, wherein the at least one alkali metal is sodium, potassium or caesium.
34. An engine according to claim 31, wherein the at least one lanthanide metal is cerium, praseodymium or lanthanum.
35. An engine according to any preceding claim, wherein the or each support comprises at least one of alumina, silica-alumina, ceria, magnesia, titania, zirconia, a zeolite or a mixture, composite oxide or mixed oxide of any two or more thereof.
36. An engine according to claim 35, wherein the support comprises lanthanum-stabilised alumina.
37. An engine according to any of claims 1 to 34, wherein the support comprises at least one basic metal.

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38. An engine according to claim 37, wherein the at least one basic metal comprises at least one of zirconium, cerium, lanthanum, alumina, yttrium, praseodymium, barium and neodymium.

39. An engine according to claim 38, wherein the support comprises ceria and zirconia, optionally in a weight ratio of from 5:95 to 95:5.

40. An engine according to any preceding claim, wherein the catalyst contains from 0.1 to 30%, optionally 0.5-15%, preferably 1-5%, by combined weight of Pt and Pd based on the total weight of the catalyst.

41. An engine according to any preceding claim, wherein the catalyst contains a weight ratio of from 95:5 to 10:90 Pd:Pt.

42. An engine according to any preceding claim, wherein the exhaust system comprises from 30-300g/ft³ Pd and from 30-300g/ft³ Pt.

43. An engine according to any preceding claim, wherein the catalyst contains from 0.1 to 10% Pt by weight based on the total weight of the catalyst and from 0.1 to 20% by weight based on the total weight of the catalyst.

44. A diesel engine according to any preceding claim, optionally a light-duty diesel engine.

45. A vehicle comprising an engine according to any preceding claim.

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46. A process for operating a compression ignition engine comprising an exhaust system comprising a supported palladium (Pd) catalyst associated with at least one base metal promoter and an optionally supported platinum (Pt) catalyst associated with and/or downstream of the Pd catalyst, which process comprising running the engine in a first, normal running mode and switching the engine to a second running mode producing exhaust gas comprising an increased level of carbon monoxide (CO) relative to the first mode wherein the CO is oxidised by the supported Pd catalyst during second mode operation, which switching step being effected when a value of at least one measurable

parameter indicative of a condition of the engine is within or outside a pre-determined range.

5 47. A process according to claim 46, wherein the at least one measurable parameter is selected from the group consisting of exhaust gas temperature; catalyst bed temperature; mass flow of exhaust gas in the system; manifold vacuum; ignition timing; engine speed; throttle position (accelerator position); the lambda value of the exhaust gas; the quantity of fuel injected in the engine; the position of the exhaust gas recirculation (EGR) valve and thereby the amount of EGR; boost pressure; and engine coolant temperature.

10 48. A method of increasing the rate of a reaction catalysed by an optionally supported platinum (Pt) catalyst in an exhaust gas of a compression ignition engine, which method comprising the step of increasing the level of carbon monoxide (CO) in the exhaust gas and creating an exotherm to heat the Pt catalyst by oxidising the CO over a supported
15 palladium (Pd) catalyst associated with at least one base metal promoter, wherein the optionally supported Pt catalyst is associated with and/or downstream of the Pd catalyst.

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